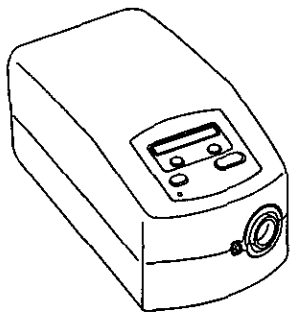
Service Center #92

Virtuoso® LX
Smart CPAP System

Service Manual



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Limited Warranty

Respironics warrants that the Virtuoso LX Smart CPAP System shall be free from defects of workmanship and materials and will perform in accordance with the product specifications for a period of two years from the date of sale by Respironics. If the product fails to perform in accordance with the product specifications, Respironics will repair or replace—at its option—the defective material or part. Respironics will pay customary freight charges from Respironics to the dealer location only. This warranty does not cover damage caused by accident, misuse, abuse, alteration, and other defects not related to materials or workmanship.

Respironics disclaims all liability for economic loss, loss of profits, overhead, or consequential damages which may be claimed to arise from any sale or use of this product. Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty is given in lieu of all other express warranties. In addition, any implied warranty, including any warranty of merchantability or fitness for the particular purpose, is limited to two years. Some states do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

The warranty for repairs is 90 days for labor and one year on the part(s) that was replaced.

To exercise your rights under this warranty, contact your local authorized Respironics dealer or contact Respironics at:

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Overview: Virtuoso LX Smart CPAP System

Warranty		Details the Respironics warranty.
Table of Contents		Lists the chapters included in this manual.
Chapter 1:	**Introduction**	Introduces the Virtuoso LX Smart CPAP System.
Chapter 2:	**Warnings, Cautions, and Notes**	Lists the Warnings, Cautions, and Notes.
Chapter 3:	**Specifications, Features, Description, and Theory of Operation**	Describes the theory of operation for the Virtuoso LX unit, including basic operations of the subsystems.
Chapter 4:	**System Setup Procedures**	Details system setup, including instructions on the Therapy Menu Display Screens and Required, Alternate, and Optional Patient Accessories.
Chapter 5:	**Routine Maintenance**	Provides cleaning and routine maintenance instructions.
Chapter 6:	**Troubleshooting and Diagnostics**	Provides troubleshooting flow charts and error code definitions.
Chapter 7:	**Repair & Replacement**	Describes detailed procedures of removing and installing all major components within the unit, including graphics and photographs for visual identification.
Chapter 8:	**Testing**	Includes the User Interface Checkout Procedure, System Functional Test, Run-in Test, Post Testing Pressure Setup, and Data Sheet.
Appendix A:	**Tools and Equipment**	Details the necessary tools and test equipment required for servicing.
Appendix B:	**Schematics**	Provides Printed Circuit Assembly (PCA) schematics.

NOTE: These are proprietary and are to be used for reference only.

Index:	Item location guide.

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Chapter 1: Introduction

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Chapter 1: Introduction

1.1 Virtuoso LX Smart CPAP System Overview

The Virtuoso LX Smart CPAP System (Virtuoso LX), shown in Figure 1-1, is a microprocessor-controlled device that delivers Continuous Positive Airway Pressure (CPAP) therapy in three modes for the treatment of adult Obstructive Sleep Apnea (OSA) only. The CPAP mode provides a constant level of positive pressure throughout the breathing cycle to pneumatically splint the airway open. The Auto-CPAP mode delivers constant positive pressure which is automatically adjusted to provide the pressure throughout the breathing cycle required to meet the patient's needs. The Split Night with Auto-CPAP mode is intended for use with split night applications. This mode delivers low, continuous positive airway pressure for a preset delay time. When the delay time ends, the Virtuoso LX will be in the Auto-CPAP mode. The delay time will not be repeated, and the system will remain in the Auto-CPAP mode.

The unit incorporates a control pad with a Liquid Crystal Display (LCD), Light-Emitting Diode (LED), operational keys, internal audible and visual alarms, a ramp feature, and a communications connector for use with the Encore® Data Management Software (version 2.5a or higher). The unit may be operated using either AC (100 - 240 VAC) or DC (12 VDC) power.

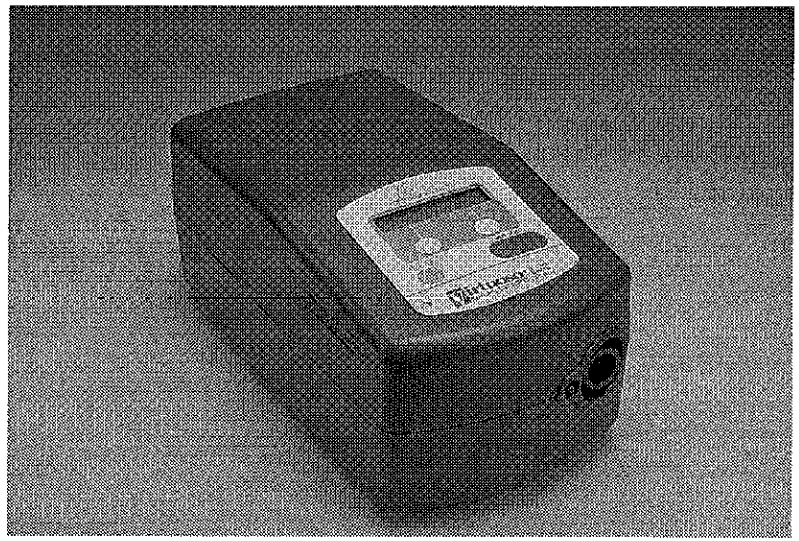

Figure 1-1
Virtuoso LX Smart CPAP System

1.2 Service Notice

This service manual was prepared by Respironics primarily for use by technicians to service the Virtuoso LX System. The individuals using this manual to service the Virtuoso LX System should have prior training or experience servicing ventilatory devices.

Only limited repairs and testing may be performed on this unit. For any major repairs, the System Final Test must be performed at a Respironics Service Center equipped with a Virtuoso LX Calibration Station.

1.3 Technical Support Statement

Respironics is committed to customer satisfaction and may be contacted with any questions or for technical support.
For technical assistance or replacement part ordering information contact your nearest Respironics Customer Satisfaction Center (CSC).

U.S. and Canada

Phone: **1-800-669-9234**
Fax: **Available from your nearest CSC**

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Phone: **001-412-731-2100**
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Chapter 2: Warnings, Cautions, and Notes

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Chapter 2: Warnings, Cautions, and Notes

WARNING:	Indicates the possibility of injury to the patient, operator, or technician.
CAUTION:	Indicates the possibility of damage to the device.
NOTE:	Places emphasis on an operating characteristic.

2.1 WARNINGS

2.1.1 Safety

- This device is intended for adult use only.
- This device is not intended for life support or life sustaining applications.
- The instructions in this manual are not intended to supersede established medical protocols.

2.1.2 Operational

- This warning applies to most Continuous Positive Airway Pressure (CPAP) devices. At low CPAP pressures, the air flow through the exhalation port may not be enough to clear all of the exhaled gas (CO_2) from the mask. You may breathe in some of the air that you have exhaled.
- Under certain conditions, the temperature of the air flow from this device can be as much as 18°F (10°C) higher than the air temperature in the room. Caution should be exercised if the room temperature is warmer than 90°F (32°C).
- If oxygen is used with this device, the oxygen flow must be turned off when the device is turned off. If the device's air flow is turned off and the oxygen flow is left on, oxygen may accumulate in the Virtuoso LX Smart CPAP System (Virtuoso LX) enclosure and may create a risk of fire. This warning applies to most types of CPAP devices.
- When supplemental oxygen is used at a fixed flow rate, inhaled oxygen concentrations will vary depending on pressure settings, patient breathing patterns, mask selection, and leak rate.
- Oxygen supports combustion. Do not use oxygen in the presence of open flames, cigarette smoke, electrical spark, or other sources of ignition.

Warnings (Continued)

- This device is not suitable for use in the presence of a flammable anesthetic mixture with air or with oxygen or nitrous oxide.
- In situations where risk of contamination between the user and the device is high (e.g.: sleep lab devices; rental devices; users with respiratory infections), a low-resistance, main flow bacteria filter should be placed in-line between this device and the circuit.
- Most CPAP devices have the potential to induce rebreathing of exhaled air. To reduce this potential, use only Respironics circuit accessories, do not wear the mask and headgear for more than a few minutes while the unit is not operating, and do not block or try to seal the vent holes in the exhalation port.

2.1.3 Service

- Electronic components used in this device are subject to damage from static electricity. Repairs made to this device must be performed only in an antistatic, Electro-Static Discharge (ESD) protected environment.
- To assure the safety of the service technician and the specified performance of the device, Respironics recommends that only technicians having prior training or experience servicing ventilatory devices perform any repairs or adjustments to the Virtuoso LX.
- High voltages are present inside this device. To avoid electrical shock, disconnect the electrical supply before attempting any repairs on the device.

2.1.4 Cleaning

- To avoid electrical shock, disconnect the electrical supply before cleaning the Virtuoso LX. DO NOT immerse this device into any fluids.

2.2 CAUTIONS

- Federal law (U.S.) restricts this device to sale by, or on the order of, a physician.
- Care should be taken to avoid exposure of the Virtuoso LX to temperatures at or near the extremes of those specified in Chapter 3. If exposure to such temperatures has occurred, the device should be allowed to return to room temperature before being turned on.
- Always use an intake filter when the Virtuoso LX is in use.
- Never place liquids on or near the Virtuoso LX.
- Discontinue using this device if any of the parts are damaged. Replace any damaged parts before continuing use.
- The information in this manual is provided for service personnel reference and is not intended for system setup or use. System setup should be performed by appropriate personnel using Home Care Dealer Instructions.

2.3 NOTES

- Refer to the Virtuoso LX User's Manual for product use additional warnings, cautions, and notes.

Additional WARNINGS, CAUTIONS, and NOTES are located throughout this manual.

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Chapter 3: Specifications, Features, Description, and Theory of Operation

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Chapter 3: Specifications, Features, Description, and Theory of Operation

3.1 Overview

This chapter describes the Virtuoso LX Smart CPAP System specifications and system features, and provides a functional description and theory of operation of the unit.

3.2 Specifications

ENVIRONMENTAL:

Operating Temperature	41 – 104°F (5 – 40°C)
Storage Temperature	-4 – 140°F (-20 – 60°C)
Humidity	15 – 95% non-condensing
Outlet Temperature Rise	Shall not exceed 122°F (50°C) when operating at a maximum ambient temperature of 104°F (40°C).

NOTE: The outlet temperature rise can be as much as 18°F (10°C) higher than room temperature measured at the end of a 6 ft. tube.

Atmospheric Pressure	83 – 102 kPascals (Storage: 50 – 102 kPascals)
Elevation	0 – 5,500 ft. (0 – 1.67 km) with three selected ranges available.
Noise Level	No specification is given because various test instruments, test procedures, and unit operating conditions produce varying results.

FUSES:

Fuses	There are no replaceable fuses.

PHYSICAL:

Electrical Safety	IEC 601-1, general safety requirement for medical devices
Dimensions	10.00" (L) x 5.50" (W) x 4.75" (H) (25 x 14 x 12 cm)
Weight	3.5 lbs (1.6 kg)

ELECTRICAL:

AC Input Voltage	93 – 126 VAC; 207 – 264 VAC; 47 – 63 Hz
DC Input Voltage	12 VDC
AC Current Consumption	1.0 A maximum
DC Current Consumption	3.0 A maximum
Power Consumption	80 VA maximum
Class	Class I for units with a 3-prong AC power inlet. Class II for units with a 2-prong AC power inlet.
Type	Type BF

FUNCTIONS:

Modes	CPAP; Auto-CPAP ; Split Night with Auto-CPAP

Specifications (Continued)

EMC NORMATIVE DOCUMENTS:

This product complies with the requirements found in the following documents:

IEC 601-1-2	Medical electrical equipment, general requirements for safety, and electromagnetic compatibility.
IEC 801-2	Electrostatic discharge requirements for industrial process measurement and control equipment.
IEC 801-3	Radiated electromagnetic field requirements for industrial process measurement and control equipment.
IEC 801-4	Electrically fast transients for industrial process measurement and control equipment.
CISPR 11	Limits and methods of measurement of electromagnetic disturbance characteristics of industrial, scientific, and medical (ISM) equipment.

RAMP:

NOTE: The Ramp feature is only available in the CPAP mode.

Minimum Ramp Press	4.0 – 20.0 cm H_2O
Ramp Resolution	1.0 cm H_2O
Ramp Time	0 – 45 minutes
Ramp Time Resolution	5 minute increments

ALTITUDE COMPENSATION:

Pressure Range	83 – 102 kPascals
Settings	Low (0 – 1,800 ft; 0 – 548 m)
	Mid (Medium) (1,801 – 3,600 ft; 549 – 1,097 m)
	High (3,601 – 5,500 ft; 1,098 – 1,677 m)

COMPLIANCE METER:

Compliance Meter (LCD)	Total Operation Time Time at Pressure Percent Memory Remaining

Specifications (Continued)

PRESSURE:

AC Operation	3.0 – 20.0 cm H_2O
DC Operation	3.0 – 20.0 cm H_2O
CPAP Mode	3.0 – 20.0 cm H_2O
Auto-CPAP Mode	Min Pressure Range 3.0 – 20.0 cm H_2O Max Pressure Range min pressure setting – 20.0 cm H_2O
Split Night with Auto-CPAP Mode	3.0 – 20.0 cm H_2O
Resolution	1.0 cm
Accuracy	±1.3 cm H_2O or 15% of the indicated control setting (whichever is greater). This tolerance assumes system setup similiar to maximum pressure test.
Setting Stability	±1.3 cm H_2O over 8 hours

THERAPY MEMORY:

Therapy Memory	Retrievable by Encore Software (version 2.5a or later)

CPAP Mode

Min Capacity	9 months
Content	Pressure Setting Date / Time of Each Use Duration at Pressure Ramp Usage

Auto-CPAP Mode

Max Capacity	4.5 months (at 6 hours / night usage)
Content	Pressure Setting Date / Time of Each Use Duration at Pressure Pressure Summary (peak, mean)

3.3 System Features

AC Power Connector	Connect the AC power cord here.
Air Outlet Port	Connect the flexible tubing here.
Communications Connector	For clinical use with the Encore Data Management Software (version 2.5a or higher). Connect the communications cable here.
DC Power Connector	Optional DC power connection.
LCD Display	Displays all system settings, total operating time, and therapy hours.
Filter Cap & Filters	The pollen filter screens out normal household dust and pollens. This must be in place at all times when the Virtuoso LX is operating. An optional, ultra-fine filter is also included for more complete filtration of very fine particles. The filter cap can be positioned to direct the air flow away from your bedside.
Outlet Swivel w / Pressure Tubing	This is connected between the Virtuoso LX's air outlet and the flexible tubing. Connect the pressure tubing to the pressure port.
Pressure On / Off Button	This button turns the air flow either on or off.
Pressure Port	Connect the pressure tubing here.
Ramp / Reset Button	This button decreases the pressure to the minimum ramp pressure setting.
LED Signal Light	The green light signals when the Virtuoso LX is ready for use. The light will go out when the air flow is turned on. A flashing light signals that the Virtuoso LX needs to be serviced.
User Buttons	These buttons can be used to change some of the System settings.

3.4 Functional Description

The Virtuoso LX Smart CPAP System (Virtuoso LX) is a microprocessor-controlled Continuous Positive Airway Pressure (CPAP) device that produces positive pressure.

The Virtuoso LX operates in three modes. The CPAP mode delivers continuous positive airway pressure, maintaining a constant level of pressure throughout the breathing cycle. CPAP mode pressure range in AC and DC operation: 3.0 – 20.0 cm H_2O. The Auto-CPAP mode automatically adjusts the air flow throughout the breathing cycle to provide the pressure required to meet the patient's needs. Auto-CPAP mode minimum pressure range: 3.0 – 20.0 cm H_2O. Auto-CPAP mode maximum pressure range: minimum pressure setting – 20.0 cm H_2O. The Split Night with Auto-CPAP mode is intended to facilitate split night sleep studies. This mode delivers a low, continuous positive airway pressure for a preset delay time. When the delay time ends, the Virtuoso LX will be in the Auto-CPAP mode. The delay time will not be repeated, and the system will remain in the Auto-CPAP mode. Split Night with Auto-CPAP mode pressure range: 3.0 – 20.0 cm H_2O.

Integral to the generation of air flow is the blower assembly. Ambient air is drawn through the air intake filter, and pressurized by the energized blower. Ultimately, therapeutic pressure is provided to the patient via the patient circuit. The microprocessor regulates the motor speed, which in turn adjusts and controls the pressure.

The Virtuoso LX's control pad, which includes four push buttons and a Light-Emitting Diode (LED) signal light, is the primary means by which the patient therapy is controlled. Patients have limited access to unit parameters.

The unit may be powered from either AC (100-240 VAC) or from DC power (12 VDC). AC power enters the unit via an AC inlet and appropriate power cord. A DC power connector enables the patient to use the system when AC voltage is not accessible.

The two system filters, the pollen and the ultra-fine, ensure optimum operation for the user. An air outlet port allows for connection to the patient circuit.

The patient circuit is made up of the flexible tubing, outlet swivel with pressure tubing, exhalation port, and nasal mask. The unit applies CPAP to the patient's upper airway to keep the airway open during the sleep. Air flow generated from the unit is directed to the patient via a mask and flexible tubing that connects to the air outlet port of the unit.

The ramp feature, available only in the CPAP mode, lets the user reduce the pressure from the Virtuoso LX so that the patient can fall asleep at a lower, more comfortable pressure at any time or as many times as needed during the night.

The Virtuoso LX is intended to deliver CPAP therapy only. It is not intended for life support or life sustaining applications. The following sections describe the major components of the Virtuoso LX and its basic theory of operation.

3.5 Theory of Operation

3.5.1 Control Pad & Liquid Crystal Display (LCD)

The control pad consists of a signal light and four user buttons (ramp button, On / Off button, and right and left user buttons for other functions). The On / Off button activates and deactivates the pressure. The range of pressure is 3.0 to 20.0 cm H_2O with AC and DC operation. The Ramp button initiates a ramp cycle which incrementally and automatically increases the pressure. The Ramp begins at the minimum ramp pressure setting, and over the specified time period, increases until the therapeutic pressure is reached. Ramp time is adjustable from 0 to 45 minutes in five minute increments. The signal light indicates power and pressure On / Off status. Three altitude compensation levels (low, medium, and high) may also be set. An LCD is used to show various operating parameters while the unit is powered.

3.5.2 Main Printed Circuit Assembly (Main PCA)

The Main PCA is the control center of the Virtuoso LX. The Main PCA utilizes a microcontroller chip which reads from and writes to various I/0 devices (control pad, LCD, memory, pressure sensor, motor control circuitry, RS-232 interface, etc.). With all of this information, the microcontroller makes appropriate decisions so that the blower motor is properly controlled to deliver the desired CPAP therapy in a safe and reliable manner.

The microcontroller and other interface circuitry provide closed loop control of the blower motor's speed. The blower motor is a three-phase brushless DC motor with a permanent magnet rotor and stationary coils that are connected in the "Y" configuration and serve as its stator coils. The stator coils are electrically switched or commutated by drive circuits with the power FET transistors. Proper timing and sequencing of the stator coil switching is provided by the microcontroller which senses the motor's shaft position by monitoring the back-EMF voltage in one of the motor's stator coils.

The microcontroller also sets the motor speed (and consequently the output pressure) by varying the voltage which is delivered to the motor. It does this by controlling the pulse duty cycle of a switching power supply (boost mode) on the unit's Main PCA.

The Virtuoso LX Main PCA has two memory devices which are used for non-volatile storage of information. First, a serial EEPROM Chip (found on the large PCA) is used to hold information which is specific to the CPAP unit, such as blower hours and other setup / calibration parameters. The EEPROM does not require electrical power to retain stored data.

Second, the auxiliary memory PCA (the small PCA which is mounted on top of the large PCA board) is used to hold information which is patient specific. Unlike the EEPROM, the auxiliary memory PCA requires electrical power from an on-board battery to retain data. The battery is also used to power a small microcontroller on the auxiliary memory PCA so that a time keeping function is always active on the auxiliary memory board. This allows patient data to be "time-stamped" as it is accumulated.

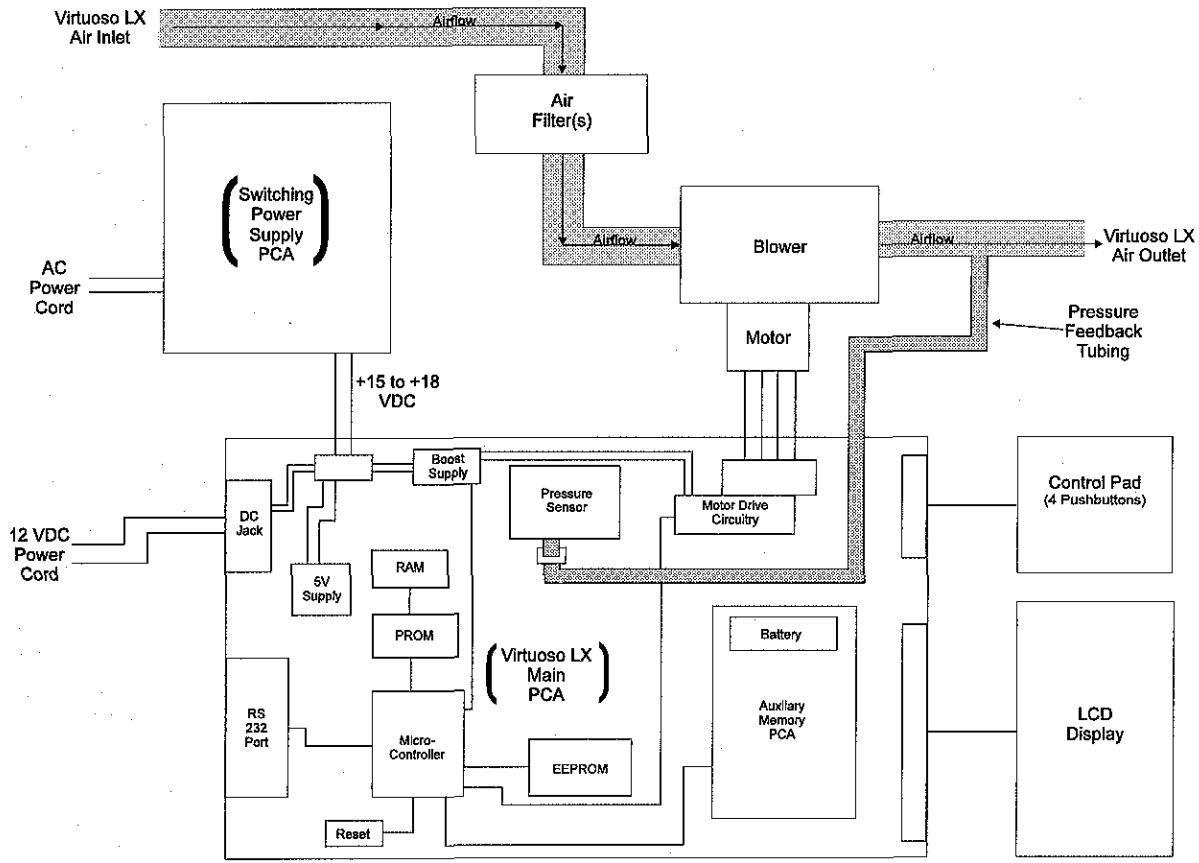
Theory of Operation (Continued)

3.5.3 Power Supply Printed Circuit Assembly (Power Supply PCA)

The unit has a switching power supply which is built on an independent PCA and mounted immediately on top of the unit's enclosure insert. The switching power supply operates properly on any AC voltage between 93 – 126 VAC and 207 – 264 VAC; 47 – 63 Hz and produces an output of approximately 16 VDC. The switching power supply automatically adjusts for input voltage. No voltage selector switch or fuse changing is required, which allows for worldwide operation.

3.6 Block Diagram

VIRTUOSO LX
System Block Diagram



3.7 Auto-off and Mask Alert Description

NOTE: This is an operational test only. No specifications or data recording are required.

3.7.1 Description of Operation

When the blower is turned on (either by Auto-on or depressing the blower on button), the Auto-on will begin after 10 seconds. After this 10 second period, the pressure will be read from the pressure sensor. If the reading from the pressure sensor is less than 1 cm H_2O and consistently remains below 1 cm H_2O for 4 seconds, the blower will be shut off, the "Connect Pressure Line" error message will be displayed, and the audible alarm will sound. Depressing any button will stop the audible alarm and clear the error massage. If no button is depressed, the audible alarm will automatically stop after 5 minutes.

NOTE: Once the test verifying pressure above 1 cm H_2O passes, it will not be re-tested.

If the unit does not read a pressure above 1 cm H_2O, it will then enter the normal mode for Auto-off. This is the mode that the unit will remain in until the blower is shut off. In this mode, the pressure is constantly examined. If the pressure drops by a certain amount within a 1.5 second period, the special Auto-off processing will begin. The amount of pressure drop to initiate this processing is dependent on the pressure that the unit is currently delivering and is contained in a table in the EPROM.

The special Auto-off processing will only begin if Auto-off is enabled and / or Mask Alert is enabled in the user menu. If neither is enabled, no further Auto-off processing will occur.

During the special Auto-off processing, the unit continues to monitor pressure. If the pressure ever rises by 1/4 of the amount that it had to drop, the special Auto-off processing is terminated and the system returns to the normal Auto-off mode as described above.

If, after 10 seconds, no pressure is detected, the unit begins looking for flow changes. If the flow remains constant and no pressure rises are detected as described above, the unit has now met the criteria for Auto-off or Mask Alert. If the Mask Alert is enabled and these conditions persist, the audible alarm will sound after 15 seconds and the display will indicate the mask is disconnected.

NOTE: The initial pressure line check cannot be disabled.

NOTE: With regard to Mask Alert, the display will continue to indicate the mask disconnected condition and the audible alarm will continue to sound for 5 minutes unless a button is pressed.

NOTE: If Auto-off and Mask Alert are both enabled, a button can be depressed, during the 15 seconds between the time that the audible alarm starts sounding and the blower is shut off, and the Auto-off condition will be reset back to its normal state and the audible alarm will stop. A subsequent pressure drop will be required to initiate the special Auto-off processing.

Auto-off and Mask Alert Description and Testing (Continued)

NOTE: Auto-off and Mask Alert are optional settings that can be enabled or disabled independent of each other.

3.7.2 Auto-off and Mask Removal Testing

NOTE: This is an operational test only. No specifications or data recording are required.

Equipment Setup:

- Connect the outlet swivel with a pressure line to the unit's pressure feedback port.
- Connect the 6 ft. smooth lumen tubing to the outlet swivel.
- Place a mask on the tubing.

Procedure:

Step 1 Verify that the Auto-off and Mask Alert are enabled.

Step 2 Turn on the blower and maintain pressure in the mask for at least 15 seconds by either breathing into the mask or by sealing the mask with your hand.

Step 3 Remove the pressure in the mask by removing it from your face or opening your hand.

Step 4 Wait 15 seconds. The Mask Alert indicator should trigger.

Step 5 Wait an additional 15 seconds. The blower should turn off.

NOTE: The Auto-off and Mask Alert indicator is intended to detect when the mask is removed by a sleeping patient. It has been designed to err on the side of staying on versus depriving a patient of therapy. If in doubt, do not turn off the Auto-off or Mask Alert feature. Movement of the mask and circuit, during the wait for the mask removal or Auto-off, should be avoided during testing of this feature. Movement can cause small pressure changes that will convince the Auto-off to stay on.

NOTE: The total time from mask removal to blower turn off is approximately 30 seconds. The total time to test Auto-off is approximately 44 seconds.

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Chapter 4: System Setup Procedures

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Chapter 4: System Setup Procedures

4.1 Overview

This section provides an overview of the system setup including detailed instructions on the Therapy menu Display screens. Refer to Chapter 7, Repair and Replacement, or Chapter 5, Routine Maintenance, for filter and filter cap installation instructions.

NOTE: This section provides directions for accessing the Therapy menu. Prescribed Therapy settings can only be set using the Therapy menu. (The patient's User's Manual provides directions to access only the Patient menu, which limits access to settings. To prevent patients from tampering with the settings, the directions to access the Therapy menu should not be revealed to the patient.)

CAUTION: If the Virtuoso LX Smart CPAP System (Virtuoso LX) has been exposed to either very hot or very cold temperatures, allow it to adjust to room temperature (approximately two hours) before beginning setup.

4.2 System Setup

Step 1 If installed, remove the protective cap from the air outlet. Install the test orifice (RI P/N 532232) onto the unit outlet. Connect the pressure tubing from the outlet port to the pressure port.

Step 2 Plug the male end of the AC power cord into an electrical outlet.

Step 3 Simultaneously, see Figure 4-2, press the two User buttons (below the display screen) and plug the female end of the AC power cord in to the AC inlet on the back of the Virtuoso LX. Hold the two User buttons down until the Virtuoso LX beeps twice.

NOTE: If a System Error 7 "key stuck" occurs, repeat the process in Step 3 again.

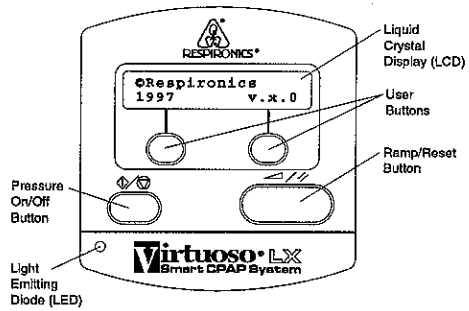


Figure 4-1
Touchpad Features

System Setup (Continued)

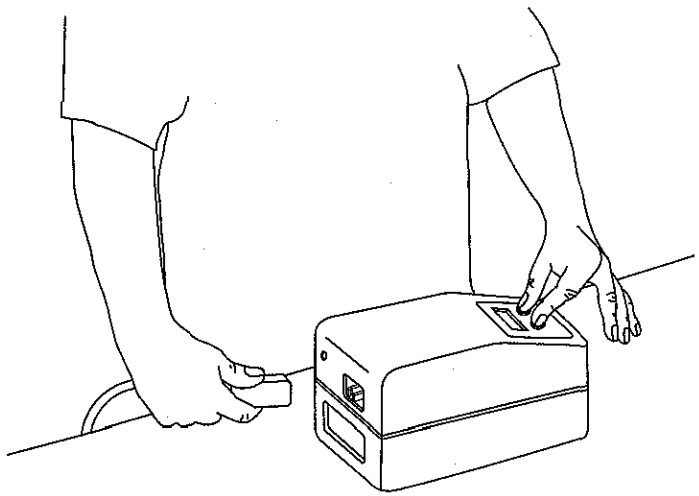


Figure 4-2
Connecting and Starting the Unit

4.2.1 Self-Diagnostic Test

After the Virtuoso LX is plugged into an electrical outlet, it will perform a Self-Diagnostic Test. The following message will then appear on the display screen.

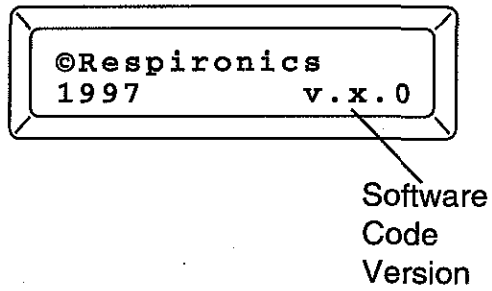


Figure 4-3
Self-Diagnostic Test

The Light-Emitting Diode (LED) will illuminate when the unit is ready for use. The light goes out when the airflow is turned on. A flashing green light signals a system error. For further instructions, refer to the Routine Use and Screen Messages sections in the User's Manual.

System Setup (Continued)

4.2.2 Display Screens

NOTE: You cannot turn the airflow on when you are in the Therapy Setup menu. When you exit this menu, the Patient Setup menu will be displayed.

NOTE: During system setup, press the left User button to confirm a correct setting, press the right User button to change an incorrect setting. Holding the right User button down will cause the values to change more quickly.

Step 1 Set the Display Language

The system can display screen information in English, French, Spanish, or German. If the language setting is correct, press the left User button. To change the language, press the right User button until the correct language is displayed. Press the left User button to confirm the setting.

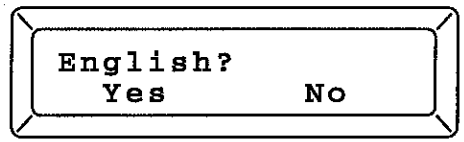


Figure 4-4
Display Language Screen

Step 2 Set the Mode

After setting the language, the current mode setting will be displayed. The system can operate in Continuous Positive Airway Pressure (CPAP), Auto-CPAP, or Split Night with Auto-CPAP mode. Refer to Section 3.1 for a detailed description of each mode. If the mode is correct, press the left User button. To change the mode, press the right User button until the correct mode is displayed. Press the left User button to confirm the setting.

Figure 4-5
Mode Setting Screen

System Setup (Continued)

Step 3 Set the Pressure

Auto-CPAP Mode Pressure Limit Settings

If Auto-CPAP mode is selected, the minimum and maximum pressures will be displayed. If the pressure setting is correct, press the left User button. To change the pressure setting, press the right User button until the correct pressure is displayed. Press the left User button to confirm the setting.

Range: Min Pressure: 3.0 – 20.0 cm H_2O
Max Pressure: Set Min Pressure – 20.0 cm H_2O
1.0 cm H_2O increments

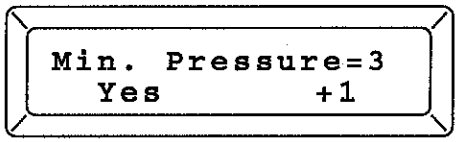


Figure 4-6
Minimum Pressure Screen

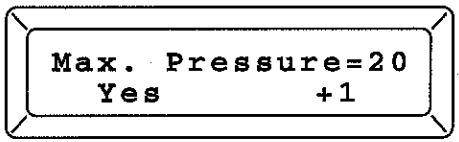


Figure 4-7
Maximum Pressure Screen

NOTE: If Auto-CPAP mode is selected, the following screens will not be displayed. Go to Step 6.

CPAP Mode Pressure Settings

If CPAP mode is selected, the CPAP pressure will be displayed. If the pressure setting is correct, press the left User button. To change the pressure setting, press the right User button until the correct pressure setting is displayed. Press the left User button to confirm the setting.

Range: 3.0 – 20.0 cm H_2O
1.0 cm H_2O increments

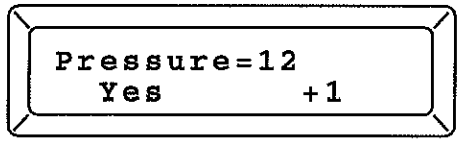


Figure 4-8
Pressure Screen

System Setup (Continued)

NOTE: If the CPAP pressure setting is 4.0 cm H_20 or below, or if the ramp time is set to "0" minutes, the ramp settings will not be displayed. Go to Step 6.

Split Night with Auto-CPAP Mode Pressure Settings

If Split Night with Auto-CPAP mode is selected, the delay pressure will be displayed. If the pressure is correct press the left User button. To change the pressure setting, press the right User button until the correct pressure is displayed. Press the left User button to confirm the setting.

Range: 3.0 – 20.0 cm H_2O
1.0 cm H_2O increments

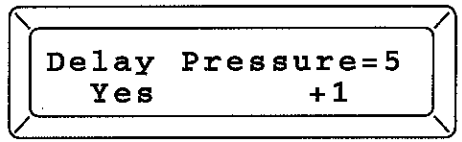


Figure 4-9
Delay Pressure Screen

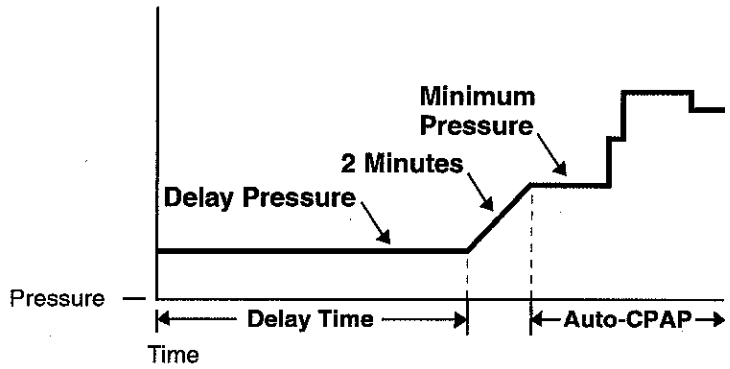


Figure 4-10
Delay Operation

System Setup (Continued)

Step 4 Set the Ramp Time

CPAP Mode Ramp Time Settings

NOTE: The ramp feature is only available in the CPAP mode.

If the CPAP mode is selected, the ramp time will be displayed. If the ramp time is correct press the left User button. To change the ramp time, press the right User button until the correct ramp time is displayed. Press the left User button to confirm the setting.

Range: 0 – 45 minutes
5 minute increments

NOTE: If the ramp time is set to "0" minutes, the following screens will not be displayed. Go to Step 6.

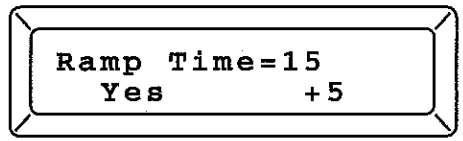


Figure 4-11
Ramp Time Screen

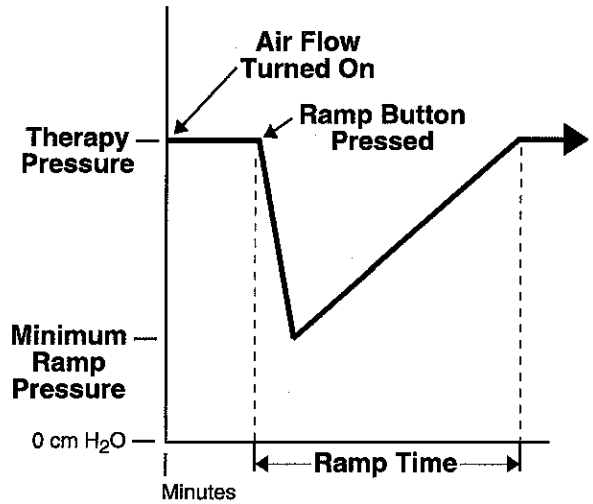


Figure 4-12
Ramp Operation

System Setup (Continued)

Split Night with Auto-CPAP Delay Time

If Split Night with Auto-CPAP mode is selected, the delay hours will be displayed. If the delay time is correct, press the left User button. To change the delay time, press the right User button until the correct time is displayed. Press the left User button to confirm the setting.

Range: 0.5 – 8 hours
(0.5 hour increments)

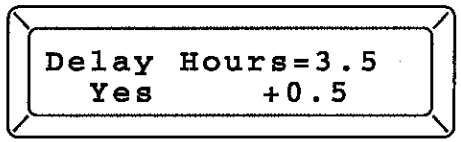


Figure 4-13
Delay Hours Screen

NOTE: If Split Night with Auto-CPAP mode is selected, the following screen will not be displayed. Go to Step 6.

Step 5 Set the Minimum Ramp Pressure

NOTE: The ramp feature is only available in the CPAP mode.

If the CPAP mode is selected, the minimum ramp pressure will be displayed. If the ramp pressure is correct, press the left User button. To change the ramp pressure, press the right User button until the correct pressure is displayed. Press the left User button to confirm the setting.

Range: 4.0 cm H_2O – CPAP pressure setting
1.0 cm H_2O increments

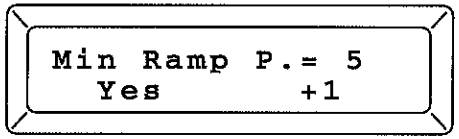


Figure 4-14
Minimum Ramp Screen

NOTE: The patient also has access to this setting in the Patient Setup menu.

System Setup (Continued)

NOTE: The following screens will be displayed for all modes.

Step 6 Set the Mask Alert

The mask alert setting will be displayed. When turned "ON", the mask alert will sound whenever a large, continuous leak (such as mask removal) has been detected in the circuit, and the correct pressure cannot be delivered to the patient. If the correct setting is displayed, press the left User button. To change the mask alert setting, press the right User button until the correct setting is displayed. Press the left User button to confirm the setting.

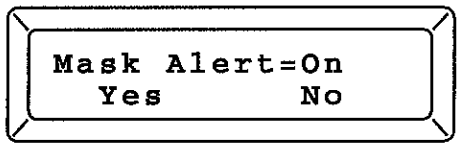


Figure 4-14
Mask Alert Screen

NOTE: The patient also has access to this setting in the Patient Setup menu.

NOTE: For a detailed description of this feature and a testing method refer to Section 8.2.

Step 7 Set the Altitude

The altitude setting will be displayed. To ensure proper therapy, this setting needs to be accurate for the patient's current location.

LOW	0 – 1,800 ft. (0 – 548 m.)
MID	1,801 – 3,600 ft. (549 – 1,097 m.)
HIGH	3,601 – 5,500 ft. (1,098 – 1,677 m.)

If the correct setting is displayed, press the left User button. To change the altitude setting, press the right User button until the correct setting is displayed. Press the left User button to confirm the setting.

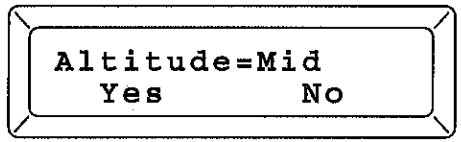


Figure 4-15
Altitude Setting Screen

NOTE: Altitudes over 5,500 ft. (1,677 m) may affect the accuracy of the pressure. Verify the pressure settings with a manometer (see Appendix A).

NOTE: The patient also has access to this setting in the Patient Setup menu.

System Setup (Continued)

Step 8 Set the Auto-on

The auto-on setting will be displayed. The auto-on feature allows the air flow to automatically turn on when the patient begins breathing through the connected circuit. Some mask types and circuit configurations may prevent the Virtuoso LX from automatically turning on. The Pressure On / Off button can always be used to turn the air flow on. If the setting is correct, press the left User button. To change the setting, press the right User button until the correct setting is displayed. Press the left User button to confirm the setting.

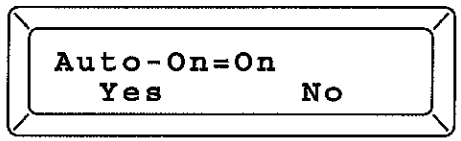


Figure 4-16
Auto-on Screen

Step 9 Set the Auto-off

The auto-off setting will be displayed. The auto-off feature allows the air flow to automatically turn off when the Virtuoso LX does not detect breathing through the connected circuit. This is usually because the mask has been removed or the tubing has become disconnected. Some mask types and circuit configurations may prevent the Virtuoso LX from automatically turning off. The Pressure On / Off button can always be used to turn the air flow off. If the setting is correct, press the left User button. To change the setting, press the right User button until the correct setting is displayed. Press the left User button to confirm the setting.

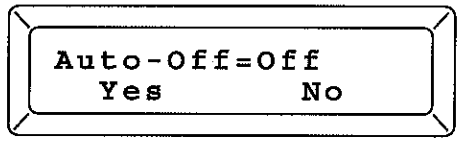


Figure 4-17
Auto-off Screen

NOTE: During Setup, if you are using a manometer to verify the pressure setting, make sure this setting is in the Off position. The airflow will automatically turn off unless it detects breathing through the circuit.

System Setup (Continued)

Step 10 Therapy Hours

The therapy hours will be displayed. This screen displays the total number of hours the patient has used the Virtuoso LX at pressure. The therapy hours can be reset to give a detailed look at patient usage. This data may be useful in tracking patient compliance. Resetting the therapy hours will not erase the total operation time or other patient data. To continue adding therapy hours to the current total, press the left User button. To erase the therapy hours, press the right User button. The total therapy hours will now read "ERASE". Press the left User button to confirm the setting.

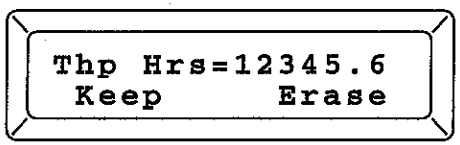


Figure 4-18
Therapy Hours Screen

Step 11 Set the Patient Data

The patient date will be displayed. The Virtuoso LX records the date, time, ramp usage, and duration of each use (minimum storage capacity: 4 months). When capacity is reached, the oldest data is overwritten. Information is retrievable by Respironics Encore Data Management Software, version 2.5 or later.

To keep the patient data that is currently being stored in the Virtuoso LX, press the left User button. To erase the patient data, press the right User button. The patient data will now read **ERASE**. Press the left User button to confirm the setting.

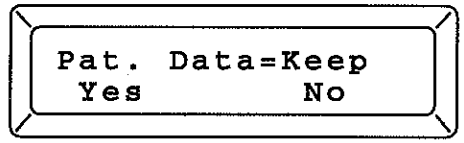


Figure 4-19
Patient Data Screen

NOTE: The Virtuoso LX stores the most recent data. You do not need to erase the data unless the Virtuoso LX is being used on different patients.

System Setup (Continued)

Step 12 Save and Exit Settings

You have now completed all of the settings. To save the setting and exit the Therapy Setup menu, press the left User button. To make further changes to the settings, press the right User button. You will be returned to the beginning of the Therapy Setup menu.

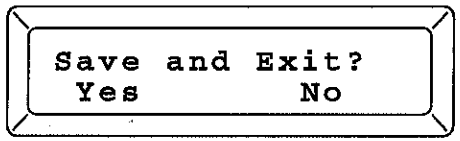


Figure 4-20
Save and Exit Screen

NOTE: To make further setting changes after you have exited the Therapy Setup menu, you must unplug the AC power cord from the Virtuoso LX for a few seconds and repeat the System Setup Procedure. If a power interruption occurs before you exit the Therapy Setup menu, the changes will not be saved.

4.3 Recommended, Alternate, and Optional Circuit Accessories

This section addresses the recommended, alternate, and optional circuit accessories that can be used with the Virtuoso LX. For additional information, refer to the User's Manual or the Home Care Providers Manual or the literature supplied with accessory.

4.3.1 Recommended Accessories

To use the Virtuoso LX system, the following accessories are recommended in order to assemble the circuit.

WARNING: The Virtuoso LX system should only be used with the recommended patient circuit identified below.

Recommended Patient Circuit

- Respironics Nasal Mask & Whisper Swivel II® Exhalation Port (or Respironics mask w/integrated exhalation port such as the Monarch® Mini Mask)
- Respironics 6 ft. (1.83 m) Flexible Tubing Assembly (reusable or lightweight)
- Respironics Headgear or Softcap™ (not shown)

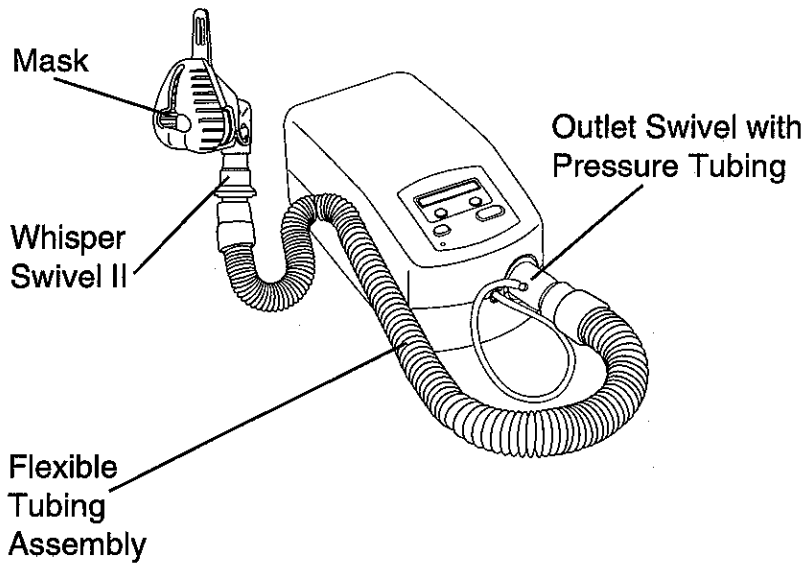


Figure 4-21
Virtuoso LX with Recommended Circuit

Required, Alternate, and Optional Circuit Accessories (Continued)

4.3.2 Alternate and Optional Circuit Accessories

The Respironics alternate accessories listed in Table 4-1 can be used in place of the recommended accessories. The optional accessories can be added to the patient circuit. Refer to Table 4-1 for changes in the pressure / flow characteristics when using these accessories.

Table 4-1, Patient Circuit Accessory Pressure / Flow Characteristics

	Pressure Drop @ 30 lpm (cm H_2O)	Pressure Drop @ 60 lpm (cm H_2O)
Recommended Patient Circuit		
Nasal Mask (disposable, reusable)	0.03	0.09
GoldSeal® Nasal Mask (reusable)	0.03	0.09
Monarch® Mini Mask	0.20	0.77
Whisper Swivel® II (reusable)	0.02	0.08
6 ft. (1.83 m) Reusable Flexible Tubing	0.11	0.30
Alternate Accessories		
Spectrum® Disposable Full Face Mask	0.04	0.10
Plateau™ Exhalation Valve (reusable)	0.05	0.20
6 ft. (1.83 m) Disposable Circuit & Exhalation Port	0.20	0.34
Optional Accessories		
Respironics Oasis™ Humidifier	0.14	0.40
24 in. Reusable Tubing (used with humidifier)	0.03	0.10
18 in. Disposable Tubing (used with humidifier)	0.00	0.00
18 in. Reusable Tubing (used with humidifier)	0.00	0.10
King Bacteria Filter (disposable)	0.74	1.65
Comfort Flap® Mask Accessory (reusable)	0.00	0.00

Required, Alternate, and Optional Circuit Accessories (Continued)

The following graph provides the exhaust / flow characteristics of the exhalation port accessories that can be used with the Virtuoso LX system. This information may help assess the CO_2 rebreathing potential of various circuit configurations at different applied pressures.

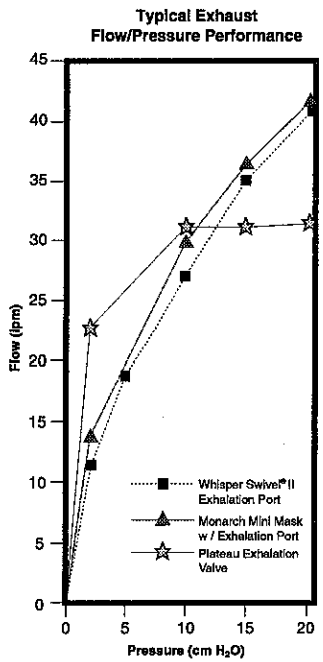


Figure 4-22
Typical Exhaust Flow / Pressure Performance

WARNING: Appropriate diagnostic pressures must be determined when alternate or optional accessories are in place. Respironics reusable circuit accessories are washable, but are for single patient use only. They are not intended to be used on multiple patients.

4.3.3 DC Power Accessories

The Respironics Shielded DC Power Cord (RI P/N 1001956) can be used to operate the Virtuoso LX system in a stationary recreational vehicle, boat, or motor home.

The Respironics DC Battery Adapter Cable (RI P/N 532209) when used with the Respironics Shielded DC Power Cord enables the Virtuoso LX system to be operated from a 12 VDC free-standing battery.

NOTE: Respironics recommends a 100 amp-hour deep cycle marine battery.

The Virtuoso LX should not be operated while the vehicle is in motion.

CAUTION: Only use the Respironics DC Power Accessories. Use of any other system may cause damage to the Virtuoso LX or your vehicle.

CAUTION: DC Power is not intended to be used as battery back-up. DO NOT connect the DC Power while the Virtuoso LX is operating on AC Power. System damage may occur.

Required, Alternate, and Optional Circuit Accessories (Continued)

4.3.4 Adding a Humidifier

When using a humidifier, always disconnect the humidifier tubing from the Virtuoso LX system when it is turned off. DO NOT use a room humidifier within 6 ft. (1.83 m) of the Virtuoso LX. Moisture can build up in the system and cause damage. Follow the instructions included with the humidifier.

The mask alert, auto-on, and auto-off function are convenience features that may not work at extreme altitude levels, or with some mask types or circuit configurations (e.g.: pass-over humidifier; full-face mask). If this occurs, the Pressure On/Off button on the Virtuoso LX should be used to turn the airflow on or off. This will not adversely affect the therapy received from the system.

4.3.5 Adding Oxygen to the System

Please note the warnings listed below when using oxygen with the Virtuoso LX system.

WARNING: When using oxygen with the Virtuoso LX system, turn the Virtuoso LX on before turning the oxygen on. Turn the oxygen off before turning the Virtuoso LX off. This will prevent oxygen accumulation in the room.

WARNING: Oxygen supports combustion. Do not use oxygen in the presence of open flames, cigarette smoke, electrical spark, or other sources of ignition.

4.4 Operating Time and Available Memory

To display the total operating time and the available memory, press the User button. The usage hours will be displayed for 10 seconds and then return to the main screen.

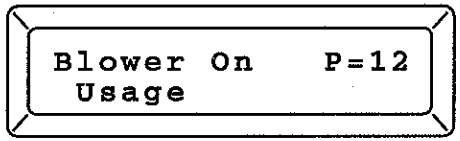


Figure 4-23
Blower Screen

4.4.1 Operating Time and Available Memory Display

M= The percentage of memory space available. The Virtuoso LX Smart CPAP System records patient usage information (e.g.: a history of pressure settings, time the system was used for therapy). Some physicians and home care providers record this information to assist in the patient's CPAP treatment. When 000% is displayed, the memory is full and the current data will start to overwrite the oldest data.

T= The therapy hours are the total number of hours the Virtuoso LX has operated at therapeutic pressure. The therapy hours can be reset to give a detailed look at patient usage.

B= The total blower time is the total number of hours the Virtuoso LX has been in use. This total includes factory testing time.

Exit= Returns the display to the main screen.

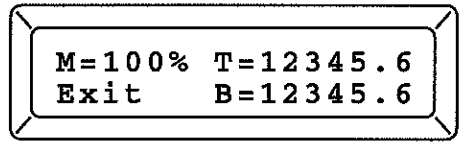


Figure 4-24
Memory, Therapy Hours, and Blower Time Screen

4.5 Clear Time Meters and Deep Sleep Screens

NOTE: This section provides directions for accessing the Clear Time Meters and Deep Sleep Screens. To prevent patients from tampering with the settings, the directions to access these screens should not be revealed to the patient.

The Clear Time Meters and Deep Sleep Screens can be accessed in the following manner.

Step 1 Plug the male end of the AC power cord into an electrical outlet.

Step 2 Simultaneously press the right User button (below the display screen) and the Pressure On / Off button, and plug the female end of the power cord into the AC inlet on the back of the Virtuoso LX, see Figure 4-25. Hold the two buttons down until the Virtuoso LX beeps twice.

NOTE: Screen values are examples only. Actual values will vary.

Step 3 Using the flow chart on page 4-20, press the ramp button six times to proceed to the Clear Time Meters Screen.

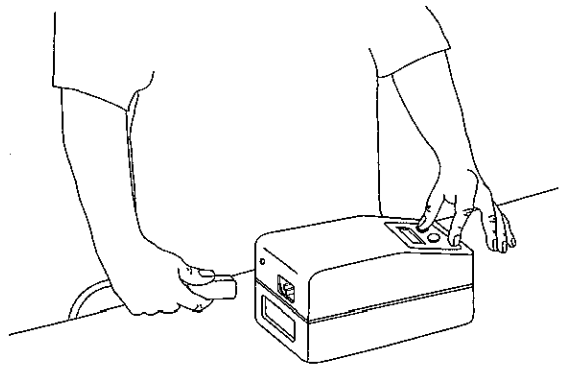
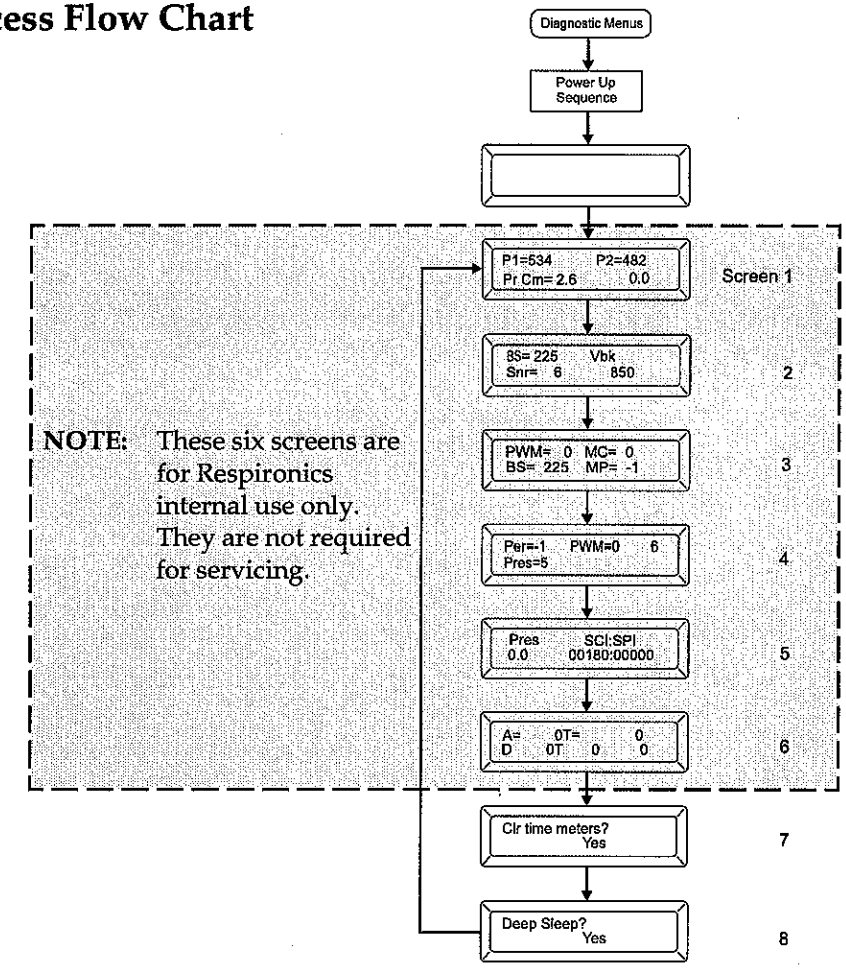


Figure 4-25
Connecting and Starting the Unit

Clear Time Meters and Deep Sleep Screens Access Flow Chart



Clear Time Meters and Deep Sleep Screens (Continued)

Step 4 The Clear Time Meters Screen is used to clear both the Therapy Time Meter and the Blower Time Meter. Press the Ramp button to advance to the next screen.

NOTE: The blower time meter should only be cleared if a blower assembly has been replaced in the unit.

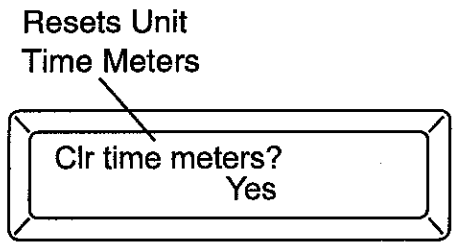


Figure 4-26
Clear Time Meters Screen

Step 5 The Deep Sleep Screen is used to place the auxiliary memory PCA into a Low Power Sleep Mode which is used to conserve the battery life of the auxiliary memory PCA. This command will also clear the memory and reset the clock to zero on the auxiliary memory PCA. Remove the AC power cord to exit these screens.

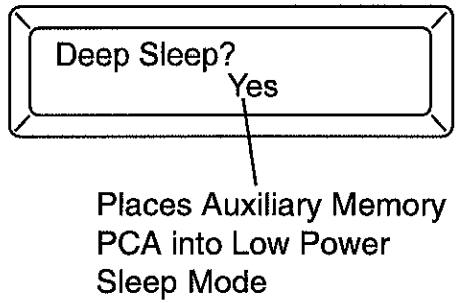


Figure 4-27
Deep Sleep Screen

NOTE: This feature should be activated if the unit is not going to be used for a period of time. This feature will automatically be disabled the next time any command is sent to the Auxiliary Memory PCA (i.e.: when the blower is activated).

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Chapter 5: Routine Maintenance

5.1 Overview 5-3

5.2 Cleaning the System 5-3

5.3 Cleaning / Replacing the Intake Filters 5-3

5.4 Virtuoso LX Smart CPAP System Preventive Maintenance Schedule 5-6

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Chapter 5: Routine Maintenance

5.1 Overview

This chapter provides guidelines and illustrates the cleaning and maintenance procedures for the Virtuoso LX Smart CPAP System (Virtuoso LX).

Before cleaning or performing any routine maintenance, always switch the Virtuoso LX unit's Pressure On / Off button to the Off position and unplug the power cord from the rear of the unit.

5.2 Cleaning the System

WARNING: To avoid electrical shock, disconnect the electrical supply before attempting to clean the Virtuoso LX. DO NOT immerse the unit in water or allow any liquid to enter the cabinet or the filter intake.

Step 1 Wipe the outside of the unit with a cloth slightly dampened with water and a mild detergent. Let the unit dry before reconnecting the electrical supply.

5.3 Cleaning / Replacing the Intake Filters

The gray pollen filter is a reusable filter that screens out pollens and some household dust. This filter should be cleaned at least once every two weeks under normal usage, or as required, and replaced with a new one every six months. One additional pollen filter is included with the system. The pollen filter must be in place at all times when the unit is operating.

The disposable white ultra-fine filter increases filtration of pollens, dust, some tobacco smoke, and small particles. The ultra-fine filter is included with the system, but is optional and should be used in addition to the pollen filter. The ultra-fine filter should never be used without the pollen filter. Replace the ultra-fine filter after 30 nights of use or sooner if it appears dirty. DO NOT clean the ultra-fine filter.

CAUTION: Failure to replace a dirty filter may cause the device to operate at higher then normal temperatures and damage the device.

5.3.1 Removing, Cleaning, and Replacing the Filters

Step 1 With the air flow turned off, disconnect the AC or DC power cord from the back of the unit.

Cleaning / Replacing the Intake Filters (Continued)

Step 2 Remove the filter cap by gently pressing down on the top of the filter cap, then pulling it away from the back of the unit.

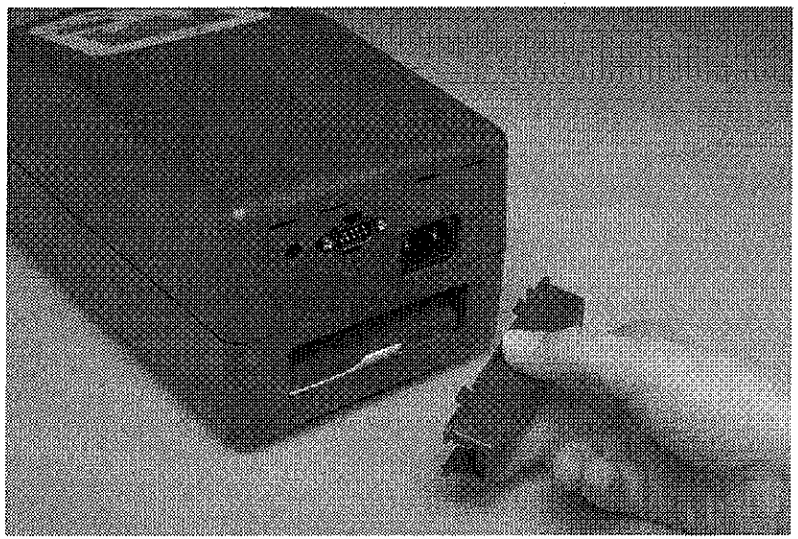

Figure 5-1
Removing the Filter Cap

Step 3 Remove the pollen filter by gently pulling the edges of the filter. Rinse the filter in a steady stream of running water. Squeeze out the water, and repeat. Allow the pollen filter to air dry on a rack for 8 to 12 hours, or in a clothes dryer for 15 to 20 minutes.

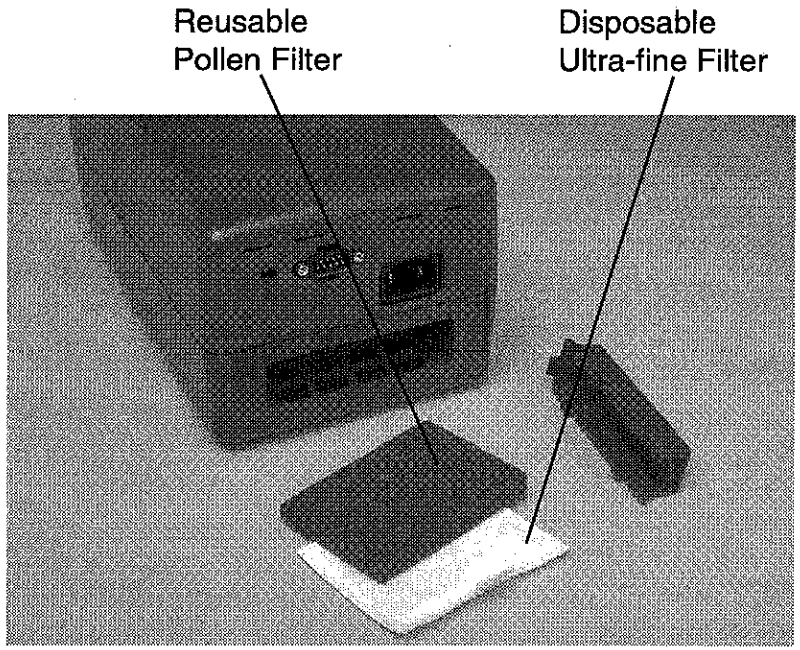

Figure 5-2
The Filter Cap and Available Filters

Cleaning / Replacing the Intake Filters (Continued)

Step 4 If you are using the white ultra-fine filter, remove the ultra-fine filter if it appears dirty and discard. Replace with a new filter. Make sure the filter is lying flat.

Step 5 Place the pollen filter over the ultra-fine filter, if used. Install the filter(s) into the filter area in the back of the Virtuoso LX.

CAUTION: The pollen filter must be completely dry before use. Never place a wet filter into the device. Respironics recommends that you clean the filter in the morning and alternate using the two pollen filters provided with the system to ensure enough drying time for the cleaned filter.

Step 6 Install the filter cap. The opening in the filter cap can be installed in either direction.

5.4 Virtuoso LX Smart CPAP System Preventive Maintenance Schedule

The following Preventive Maintenance Schedule lists the items that must be inspected or tested perodically, or after service is performed. Use the Preventive Maintenance Schedule to record the dates on which the maintenance items are performed.

You may photocopy the Preventive Maintenance Schedule for each unit serviced.

5.4.1 Virtuoso LX Preventive Maintenance Schedule (Factory Recommended)

Model No. _____ Serial No. _____ Date _____ Service Technician _____

Maintenance Item	Verification Reference	Service Interval	Date
Record hours of operation	Displayed on Options Screen	As desired	
Replace pollen filter	Section 5.3.1	Clean every 2 weeks, or as required; Change every 6 months	
Replace ultra-fine filter (if used)	Section 5.3.1	Replace after 30 nights of use (sooner if it appears dirty)	
PerformTesting Process	Section 8.1	After service is performed	
Cleaning	Section 5.2	As required	

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Chapter 6: Trouble-shooting and Diagnostics

6.1 Overview 6-3
6.2 Common System Level Problems 6-4
6.3 Troubleshooting Flow Chart 6-6
6.4 Troubleshooting Table 6-7
6.5 Error Code Chart 6-13

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Chapter 6: Troubleshooting and Diagnostics

6.1 Overview

WARNING: Electrical Shock Hazard: Disconnect the electrical supply before repairing the unit.

CAUTION: Electronic components used in this unit are subject to damage by static electricity. Use proper static discharge equipment and grounding precautions when servicing the equipment. Service only at a static-free workstation.

CAUTION: Due to required calibration after parts replacement, the following may not be field replaced unless the unit is System Final Tested at a Respironics Service Center equipped with a Great Performers Calibration Station:

- Main Printed Circuit Assembly (Main PCA)
- Power Supply Printed Circuit Assembly (Power Supply PCA)
- Blower Assembly
- Enclosure Insert
- Outlet Port
- Pressure Tubing (internal)

This section contains information necessary to troubleshoot and diagnose problems with the Virtuoso LX Smart CPAP System (Virtuoso LX). It provides a summary of common system problems as well as a flowchart and table to simplify the troubleshooting process. The error code chart lists all error codes, the associated problem, and the suggested corrective action to be taken.

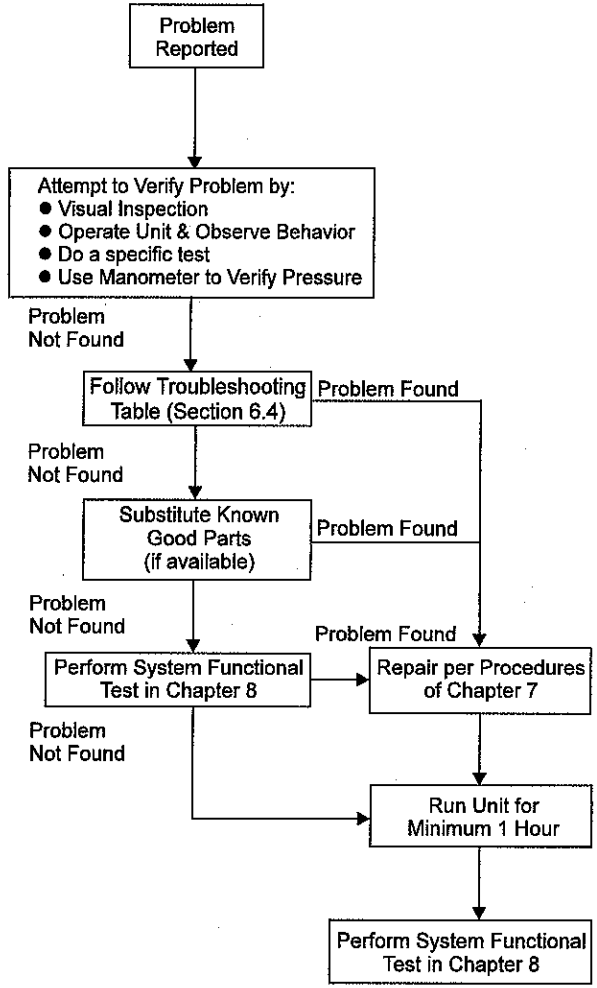
6.2 Common System Level Problems

Screen Message	Description	Result	Corrective Action
Mask Alert	A large circuit leak, such as mask removal, has been detected.	• The air flow will turn off in less than 1 minute (if the auto-off feature has been turned on). • The alert tone will sound in less than 45 seconds (if the mask alert feature has been turned on).	• Press any button on the Virtuoso LX to silence the alert tone and clear the display screen. • Check the circuit (flexible tubing assembly, pressure tubing, mask) for any leaks and adjust the mask and headgear. • Press the Pressure On / Off button to restart the air flow. **Note:** The audible mask alert setting can be turned on or off. (See the Section 4.2 - System Setup for instructions.)

Common System Level Problems (Continued)

Screen Message	Description	Result	Corrective Action
Connect Pressure Line	The flexible tubing and/or pressure tubing has become disconnected from the system.	• The air flow will turn off within 20 seconds. • The alert tone will sound within 20 seconds.	• Press any button on the Virtuoso LX to silence the alert tone and clear the display screen. • Reconnect the tubing. • Press the Pressure On / Off button to restart the air flow. **Note:** This alert setting cannot be turned on or off.
System Error # #	The Virtuoso LX is not functioning correctly and may need servicing.	• The air flow will turn off immediately. • The alert tone will sound. • The signal light will flash on and off.	• Reset the Virtuoso LX by unplugging the power cord from the electrical outlet and then plugging it in again. • If the message appears again, refer to the Error Code Chart (Section 6.5) for a description of the error and corrective action. **Note:** This alert setting cannot be turned on or off.

6.3 Troubleshooting Flow Chart


Problem Reported
Attempt to Verify Problem by:
● Visual Inspection
● Operate Unit & Observe Behavior
● Do a specific test
● Use Manometer to Verify Pressure
Problem Not Found
Follow Troubleshooting Table (Section 6.4)
Problem Found
Problem Not Found
Substitute Known Good Parts (if available)
Problem Found
Problem Not Found
Problem Found
Perform System Functional Test in Chapter 8
Repair per Procedures of Chapter 7
Problem Not Found
Run Unit for Minimum 1 Hour
Perform System Functional Test in Chapter 8

6.4 Troubleshooting Table

Symptom	Cause	Verification	Corrective Action
Audible Alert - During audible alert condition, the buzzer is not audible.	• Main printed circuit assembly.	Perform power up sequence. Visually verify the LED's and display illuminate. Reestablish original alert conditions. Listen for audible alert.	If audible alert does not work, replace Main PCA (see Note[1]). If visual indicators are not present at power up sequence, perform user interface checkout procedure (see Section 8.2). If device fails user interface checkout procedure, replace control pad. If alert is audible during both tests, no corrective action is required.
Indicator - LED or other indicator not working.	• Control pad • Interface cable loose	Perform user interface checkout procedure (see Section 8.2).	If device fails user interface checkout procedure, replace control pad. Check for secure connection of ribbon cable connector.

NOTE 1: Due to required testing, this repair must be performed at a Respironics Service Center equipped with a Great Performers Calibration Station.

Troubleshooting Table (Continued)

Symptom	Cause	Verification	Corrective Action
Display - Display is blank or contains erroneous information.	• Display assembly • Main PCA	Inspect the cable between the display and the main control board for loose ends. (Cable not backwards.)	Replace in order until solved: • Display PCA • Main PCA (see Note[1]) • Power Supply PCA (see Note[1])
Intermittent Power Supply Problem - An intermittent on / off condition exists, unit alarms randomly, or indicator lights blink sporadically.	• Power cord, AC inlet, Main PCA, loose connections. • Power Supply PCA.	Inspect power cord for fraying at cable ends. Inspect all connectors on the PCAs. 16V ± 2.5 from Power Supply PCA. +5.1V on Main PCA ± 0.25 +8V on Main PCA ± 0.4	If power supply DC voltage is not within specifications, replace Power Supply PCA (see Note[1]). If power cord or connectors are faulty, replace items as required. If +5 or +8V supplies are not within specifications, replace Main PCA (see Note[1]).

NOTE 1: Due to required testing, this repair must be performed at a Respironics Service Center equipped with a Great Performers Calibration Station.

Troubleshooting Table (Continued)

Symptom	Cause	Verification	Corrective Action
Unit does not operate from the 12 VDC power source - Unit blows fuses in the DC cord during DC operation.	Faulty DC plug, low DC voltage, fuse in DC cord is blown. Main PCA	Ensure the DC supply is a minimum of 12 VDC. Ensure the DC voltage is stable. Monitor the voltage at the back of the DC connector mounted on the Main PCA. If DC voltage is below 11.5 VDC, replace or recharge DC source. If there is no DC measured at the Main PCA, then check DC adapter cord for continuity.	• If DC cord or source is not at 12 VDC, replace or recharge as required. • If 12 VDC supply is ok, replace Main PCA (see Note[1]).
Noise -	Missing or damaged bottom strip on bottom of unit, blower malfunctioning.	Turn unit over and inspect the bottom for missing or damaged bottom strip.	• If bottom strip is missing, replace bottom strip. Tighten any loose screws. • Replace blower (see Note[1]).

NOTE 1: Due to required testing, this repair must be performed at a Respironics Service Center equipped with a Great Performers Calibration Station.

Troubleshooting Table (Continued)

Symptom	Cause	Verification	Corrective Action
Odor -	Tubing smells new, unit smells new, airborne residue buildup.	Visually inspect patient tubing for contamination.	Run unit in a clean environment for a few hours to eliminate new smell. Wash tubing with soap and water. To clear residue build-up, replace all subassemblies in the patient air stream (blower, filters, patient circuit).
Outlet air temperature - the outlet air temperature is too warm.	Filters dirty, blower, Main PCA.	Ensure the filter is clean and not restricting air flow. Monitor the outlet air temperature at the end of the six foot tubing. A rise in temperature can be expected. Ensure the unit is not next to any heat source.	Replace: in order until solved • Filter(s) • Blower (see Note[1]) • Main PCA (see Note[1])

NOTE 1: Due to required testing, this repair must be performed at a Respironics Service Center equipped with a Great Performers Calibration Station.

Troubleshooting Table (Continued)

Symptom	Cause	Verification	Corrective Action
Pressure Related Problems - The outlet pressure does not change or properly adjust.	Pressure tubing has been blocked, disconnected, or kinked. Main PCA or blower malfunction.	Inspect pressure tubing for secure connections and kinks. Check blower for air leaks.	• Secure pressure tubing connections. • Replace blower, pressure tubing, or Main PCA as required (see Note[1]).
Pressure Offset - Static pressure fluctuates -1.0 cm to +2.0 cm H_2O.	The delivered pressure is higher or lower than the set value by more than +2.0 / -1.0 cm H_2O.	Perform power up process. Check altitude setting.	• Check tubing for kinks. • Replace the Main PCA (see Note[1]).
"Connect Pressure Line" - displayed	This is a common message displayed when the tubing *disconnects from the* Virtuoso LX.	Before opening the device, occlude the outlet and turn *the air flow on. If the* message appears again, inspect pressure tubing for secure connections.	Reestablish tubing connections. Replace Main PCA (see Note[1]).
No Stored Therapy Data	Main AC Power to the unit is switched off prior to the pressure on / off being actuated.	No therapy data after usage.	Depress the pressure on / off button before diconnecting the Main AC Power.

NOTE 1: Due to required testing, this repair must be performed at a Respironics Service Center equipped with a Great Performers Calibration Station.

Troubleshooting Table (Continued)

Symptom	Cause	Verification	Corrective Action
Ramp Pressure - The pressure does not ramp correctly.	• No ramp time prescribed. • Ramp minimum pressure has to be lower than CPAP pressure. • Main PCA. • Ramp button not functioning.	Make sure the patient's prescription specified ramp. Make sure unit was set for ramp. Perform user interface checkout procedure (see Section 8.2).	Set unit for ramp. Replace Main PCA (see Note[1]). If device fails user interface checkout procedure, replace control pad or display PCA.
Pressure Variation - The pressure varies around the set value, pressure fluctuates greater than 1.0 cm H_2O.	• Internal air leak • Filters dirty • Main PCA, blower • Altitude setting • Air path blocked	Replace filters. Perform Testing Process (see Section 8.1).	Verify proper altitude setting. Replace Blower (see Note[1]). If pressure still drifts, then replace Main PCA (see Note[1]).

NOTE 1: Due to required testing, this repair must be performed at a Respironics Service Center equipped with a Great Performers Calibration Station.

6.5 Error Code Chart

Error Code	Problem	Corrective Action
0	PROM Test – The code in the PROM is corrupt.	Replace Main PCA (see Note[1]).
1	RAM Test – The RAM on the Main PCA is not functioning properly.	Replace Main PCA (see Note[1]).
2	Stack Test – The stack memory on the Main PCA is not functioning properly.	Replace Main PCA (see Note[1]).
3	NV Param Memory – A failure has been detected in the non-volatile memory on the Main PCA.	Reset parameter by simultaneously pressing the two user buttons and the Ramp button. Reconfigure unit and test for proper operation. If error repeats, replace Main PCA (see Note[1]).
4	Parameter Copies – A failure has been detected in the non-volatile memory on the Main PCA.	Reset parameter by simultaneously pressing the two user buttons and the Ramp button. Reconfigure unit and test for proper operation. If error repeats, replace Main PCA.
5	Watchdog Test – The watchdog in the 68HC16 has failed.	Replace Main PCA (see Note[1]).
6	Watchdog Timeout – The system was reset due to a watchdog timeout.	Cycle power to unit. If error repeats, replace Main PCA (see Note[1]).

NOTE 1: Due to required testing, this repair must be performed at a Respironics Service Center equipped with a Great Performers Calibration Station.

Error Code Chart (Continued)

Error Code	Problem	Corrective Action
7	Key Stuck – One of the keys is stuck in the closed position.	Verify that nothing is pressing a key. Replace control pad. If error persists, replace Main PCA (see Note[1]).
8	Boost-Bulk Test – The boost circuit on the Main PCA is not functioning.	Replace Main PCA (see Note[1]).
9	Boost V Too Low – The boost circuit on the Main PCA is not functioning.	Replace Main PCA (see Note[1]).
10	Boost V < Bulk V – The boost circuit on the Main PCA is not functioning.	Replace Main PCA (see Note[1]).
11	Boost Deriv Test – A rapid downward change was detected in the boost voltage.	Replace Main PCA (see Note[1]).
12	Motor Overspeed – The speed of the motor was determined to be above acceptable limits.	Replace blower assembly (see Note[1]). If error persists, replace Main PCA (see Note[1]).
13	Motor Underspeed – The speed of the motor was determined to be below acceptable limits.	Replace blower assembly (see Note[1]). If error persists, replace Main PCA (see Note[1]).
14	Motor Current – The motor current has exceeded its	limit. Replace blower assembly (see Note[1]). If error persists, replace Main PCA (see Note[1]).
15	Rotor Locked – The motor could not be started.	Replace blower assembly (see Note[1]). If error persists, replace Main PCA (see Note[1]).

NOTE 1: Due to required testing, this repair must be performed at a Respironics Service Center equipped with a Great Performers Calibration Station.

Error Code Chart (Continued)

Error Code	Problem	Corrective Action
16	Program Sequence – External conditions prevented the proper operation of the software.	Replace Main PCA (see Note[1]).
17	Motor Feedback – The back EMF signal from the motor was not detected.	Replace blower assembly (see Note[1]). If error persists, replace Main PCA (see Note[1]).
18	SW Error – An unexpected condition has been detected by the software.	If error persists, replace Main PCA (see Note[1]).
19	Config Jumpers – The configuration resistors on the Main PCA are in an invalid configuration.	Replace Main PCA (see Note[1]).
20	A/D Converter – The A/D converter in the 68HC16 is not functioning properly.	Replace Main PCA (see Note[1]).
21	Input V Too Low – The input voltage is reading too low for the unit to operate properly.	If running on DC jack, verify proper input voltage. Other- wise replace Main PCA (see Note[1]).
22	BUS Error – The processor tried to access a non-existent memory location.	If error persists, replace Main PCA (see Note[1]).
23	Boost Voltage too High – The boost voltage exceeds a limit of 60V for more than 30 seconds.	Replace Main PCA (see Note[1]).

NOTE 1: Due to required testing, this repair must be performed at a Respironics Service Center equipped with a Great Performers Calibration Station.

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Chapter 7: Repair & Replacement

7.1 Overview 7-3

7.2 Virtuoso LX Smart CPAP System Repair Kits 7-5

7.3 Warnings and Cautions 7-8

7.4 Replacement Instructions 7-8

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Chapter 7: Repair & Replacement

7.1 Overview

Figure 7-1 lists the names and identifies the locations of the replaceable components in the Virtuoso LX Smart CPAP System (Virtuoso LX). The drawing provides a quick reference and overview of the unit. Within each replacement section, more detailed support information is provided to illustrate the exact component location and replacement procedure(s).

CAUTION: Due to required calibration after parts replacement, the following may not be field replaced unless the unit is System Final Tested at a Respironics Service Center equipped with a Great Performers Calibration Station:

- Main Printed Circuit Assembly (Main PCA)
- Power Supply Printed Circuit Assembly (Power Supply PCA)
- Blower Assembly
- Enclosure Insert
- Outlet Port
- Pressure Tubing (internal)

For technical assistance or replacement part ordering information contact your nearest Respironics Customer Satisfaction Center (CSC).

U.S. and Canada

Phone: **1-800-669-9234**
Fax: **Available from your nearest CSC**

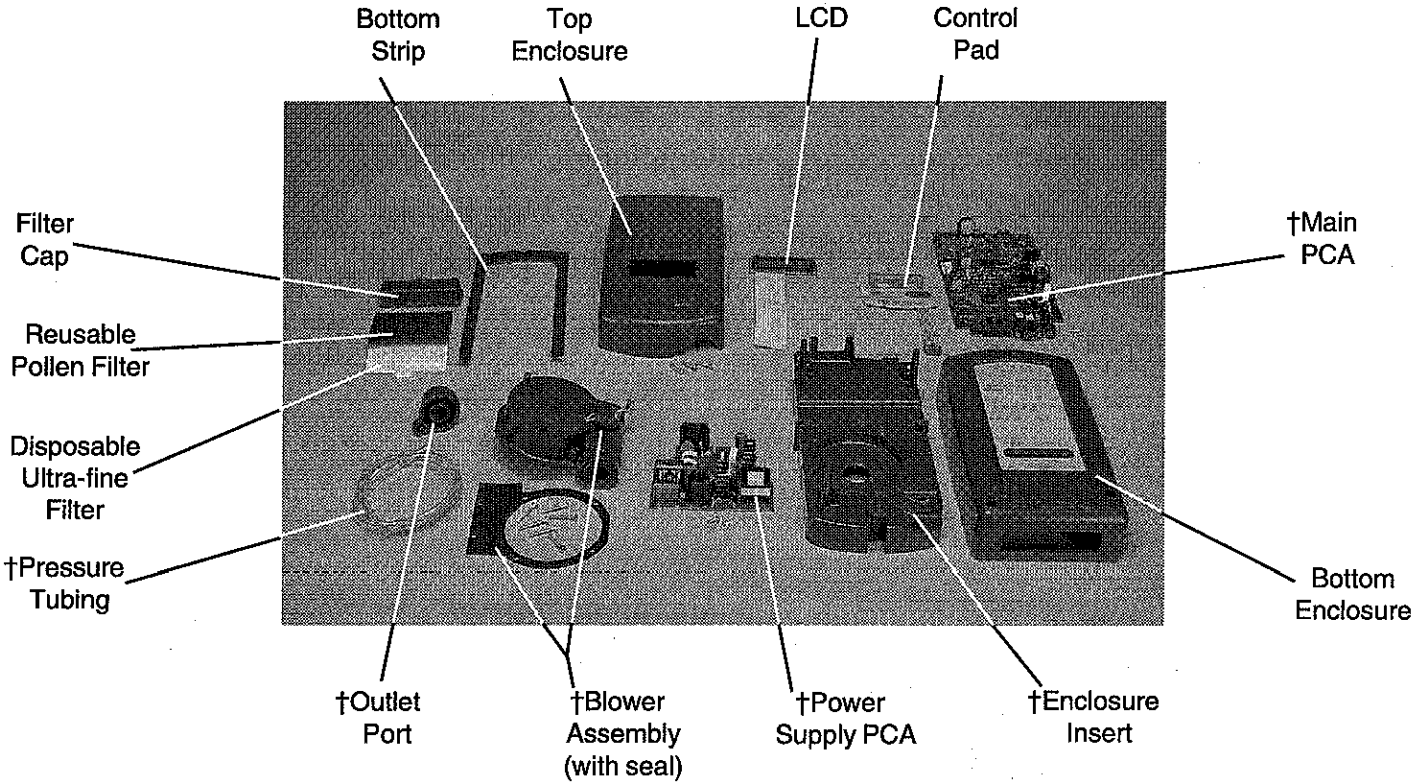
International

Phone: **001-412-731-2100**
Fax: **001-412-473-5012**

Visit Respironics Home Page on the World Wide Web at:

www.respironics.com

7.1.1 Virtuoso LX Smart CPAP System Exploded View



†CAUTION: Due to required testing after replacement, these items are only replaceable at a Respironics Service Center equipped with a Great Performers Calibration Station.

Figure 7-1
Virtuoso LX Smart CPAP System Exploded View

7.2 Virtuoso LX Smart CPAP System Repair Kits

Replacement Part	Replacement Part No.	Page No.
AC Power Cord (U. S. and Canada)	622144 (3-prong) 362524 (2-prong)	N.A.
AC Power Cord (International)	See Note [2]	N.A.
Blower Assembly Includes: • Blower assembly (w / foam baffle) • Blower-to-enclosure insert seal • Pressure Tubing (31") • 6-13 × 1" screw (×6) • Pressure Tubing (14" – not used for this repair)	622115 See Note [1]	7-35
Bottom Enclosure Includes: • Bottom enclosure (w / foam baffle and label) • Bottom strip • 8-11 × 3/4" screw (×3)	See Note [3]	7-15
Bottom Strip	622122	7-11
Control Pad	622170	7-23
Display Assembly	622118	7-21
DC Power Cord, Shielded (optional)	1001956	N.A.

Virtuoso LX Smart CPAP System Repair Kits (Continued)

Replacement Part	Replacement Part No.	Page No.
Enclosure Insert Includes: • Enclosure insert (w / foam baffle) • Blower-to-enclosure insert seal	622119 See Note [1]	7-41
Filter, Disposable, Ultra-fine (×6)	622017	5-3
Filter, Reusable, Pollen (×2)	622018	5-3
Filter Cap Includes: • Filter cap (w / foam baffle)	622124	7-13
Main Printed Circuit Assembly (Main PCA) Includes: • Main PCA • Pressure tubing (31") • 6-13 × 3/8" screw (×3)	622158 See Note [1]	7-26
O_2 Enrichment Port (used for testing)	312010	N.A.
Outlet Port Includes: • Outlet port • Pressure tubing (31") • Pressure tubing (14" – not used for this repair)	622120 See Note [1]	7-33
Power Supply Printed Circuit Assembly (Power Supply PCA) Includes: • Power supply PCA • 6-13 × 1/4" screw (×4)	622126 See Note [1], See Note [4] 1001111 See Note [1], See Note [4]	7-38

Virtuoso LX Smart CPAP System Repair Kits (Continued)

Replacement Part	Replacement Part No.	Page No.
Pressure Tubing (31")	622171 See Note [1]	7-30
Service Manual	622137	N.A.
Test Orifice (used for testing)	532232	N.A.
Top Enclosure Includes: • Top enclosure (w / foam baffle) • 8-11 x 3/4" screw (x3)	622123	7-17

Comments:
- Photo is shown on page 7-4.
- All items have a quantity of one unless otherwise specified.
- Part replacement procedures are detailed within this chapter.
- Assorted tubing, cables, and hardware are supplied with each Replacement Kit.

Note 1: Due to required testing after replacement, these items are only replacable at a Respironics Service Center equipped with a Great Performers Calibration Station.

Note 2: Contact Respironics International Customer Service for further AC Power Cord information (see page 7-3).

Note 3: Contact Respironics Technical Service Department for bottom enclosure ordering information (see page 7-3).

Note 4: RI P/N 622126 is used to replace the Power Supply PCA in a unit with an existing 2-pronged AC inlet.

RI P/N 1001111 is used to upgrade an original 3-pronged unit to a 2-pronged configuration. The RP Kit includes new labeling and a 2-pronged Power Cord.

7.3 Warnings and Cautions

WARNING: To prevent electrical shock, disconnect the electrical supply before attempting to make any repairs to the Virtuoso LX CPAP unit.

CAUTION: Electronic components used in this unit are subject to damage from static electricity. Repairs made to this unit must be performed only in an antistatic, Electro-Static Discharge (ESD)-protected environment.

CAUTION: Due to required calibration after parts replacement, the following may not be field replaced unless the unit is System Final Tested at a Respironics Service Center equipped with a Great Performers Calibration Station:

- Main Printed Circuit Assembly (Main PCA)
- Power Supply Printed Circuit Assembly (Power Supply PCA)
- Blower Assembly
- Enclosure Insert
- Outlet Port
- Pressure Tubing (internal)

7.4 Replacement Instructions

See Figures 7-2 and 7-3 before removing or installing any component. These figures will detail the order in which each item must be removed or installed and should be used as a guideline for quick reference.

Replacement Instructions (Continued)

Removal Flow Chart

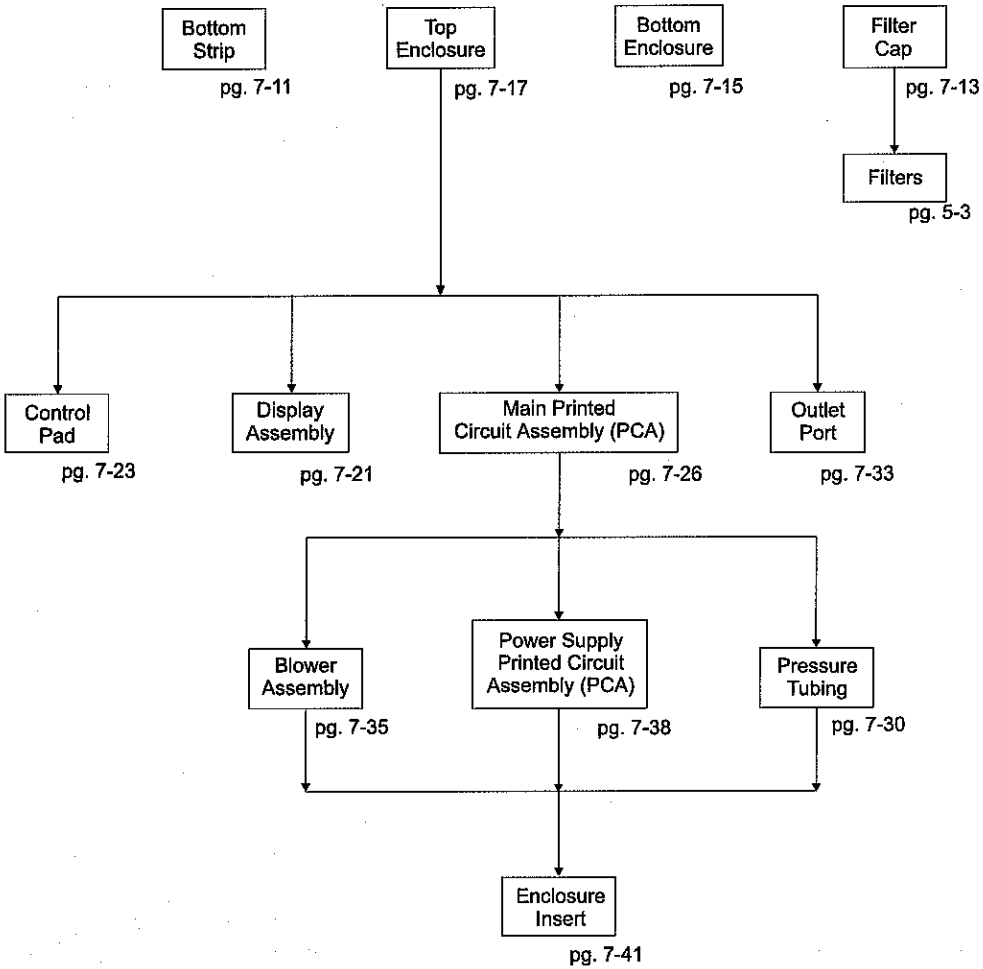


Figure 7-2
Removal Flow Chart

Chart Usage: Determine which item is to be replaced then follow the line of flow back to the "Top Enclosure" and begin the removal process. Detailed procedures begin on the referenced page numbers.

†Caution: Due to required testing after replacement, these items are only replacable at a Respironics Service Center equipped with a Great Performers Calibration Station.

Installation Flow Chart

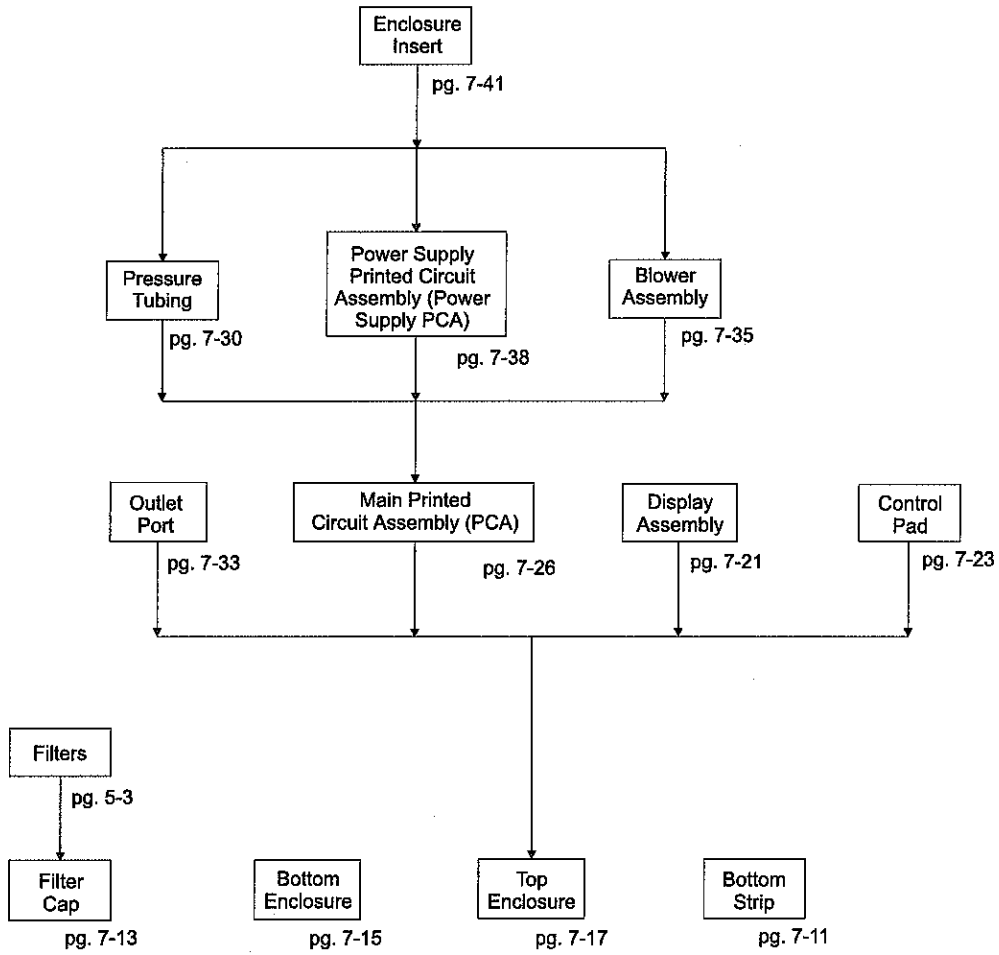


Figure 7-3
Installation Flow Chart

Chart Usage: Determine which item is to be installed then follow the line of flow down to the "Top Enclosure" and begin the installation process. Detailed procedures begin on the referenced page numbers.

†Caution: Due to required testing after replacement, these items are only replacable at a Respironics Service Center equipped with a Great Performers Calibration Station.